Earth System Science Pathfinder Program (ESSP Program)

Research Objectives

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Preproposal Conference

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Role of Exploratory Missions

- Generally address process studies (i.e., first time measurement of a phenomenon), while systematic missions focus on trend studies
- Generally one-time missions that can deliver conclusive scientific results addressing a focused science question(s)
  - No *a priori* commitment to continue the measurement, although may lead to a new systematic or operational measurement
- May focus on
  - A single pioneering measurement that opens a new window on the behavior of the Earth system
  - Or, several measurements to allow closure tests to be carried out
- Often involve new types of measurement technologies not previously flown in space, or new vantage points for more complete or frequent sampling

Exploratory Mission History

- Began as “Earth Probes”; focused, generally smaller missions (e.g., TOMS, TOPEX, TRMM, NSCAT) in parallel with EOS and its precursors
- Formalized in the Earth System Science Pathfinder program in 1996
  - Combined goals of seeking the best ideas of the broad science community and achieving low cost, rapidly developed missions
  - Opportunities to pursue science not addressed by EOS
  - Flight rate envisioned as one per year (remains unchanged)
- 1st ESSP solicitation: one mission at $60M, one at $90M (including launch costs)
  - VCL and GRACE
- 2nd ESSP solicitation: two missions at no more than $120M each (including launch costs)
  - PICASSO-CENA and Cloudsat
- Two non-ESSP exploratory mission solicitations for unique situations:
  - LightSAR from Congressional and commercial interests; none selected
  - Triana from OVP interest and ESE exploration of L1 for Earth science; L1 vantage point enables view of diurnal variation in several parameters, and contributes to several science questions (F1, R1, V4, R6)

Examples...

- **Past: TRMM**
  - Prior to TRMM, we did not know within a factor of 2 how much rain falls over the tropical oceans. Yet, this is the main transfer of energy driving atmospheric circulation.
- **Present: GRACE**
  - We currently lack a precise knowledge of the Earth's geoid and its change in time. Such knowledge will enhance understanding of:
    - Oceanography: GRACE + (Topex/Poseidon, ERS-1/2, Jason, Envisat)
      - Absolute Surface Currents
      - Deep Ocean Currents & Mass Transport
      - Long Term Sea Level Change
    - Continental Hydrology: GRACE + in-situ data
      - Evapo-transpiration & Ground Water Changes
      - Snow Loads
    - Glaciology: GRACE + IceSAT + in-situ data
      - Polar Ice Sheet Mass Balance (Global Sea Level Change)
    - Solid Earth Sciences & Geodesy: GRACE + in-situ data
      - Mantle & Lithospheric Density Variations
      - Precise Positioning

Science Questions

How is the global Earth system changing?

What are the primary forcings of the Earth system?

How does the Earth system respond to natural and human-induced changes?

What are the consequences of change in the Earth system for human civilization?

How well can we predict the changes to the Earth system that will take place in the future?

Science Questions

Earth System Variability and Trends

- How are global precipitation, evaporation, and the cycling of water changing?

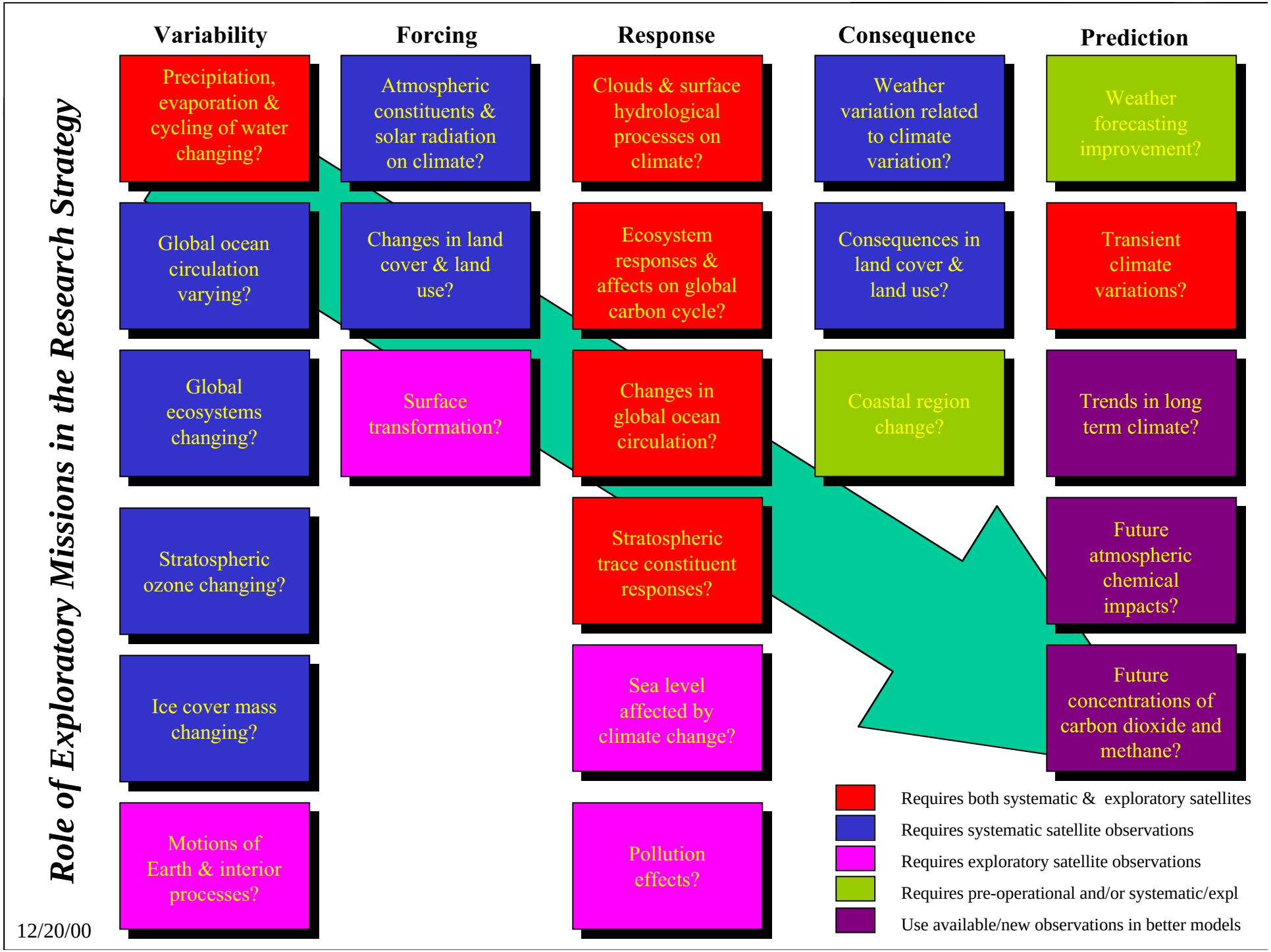
Primary Forcings of the Earth System

- What trends in atmospheric constituents and solar radiation are driving global climate?
- How is the Earth surface being transformed, and how can this information be used to predict future changes?

Science Questions

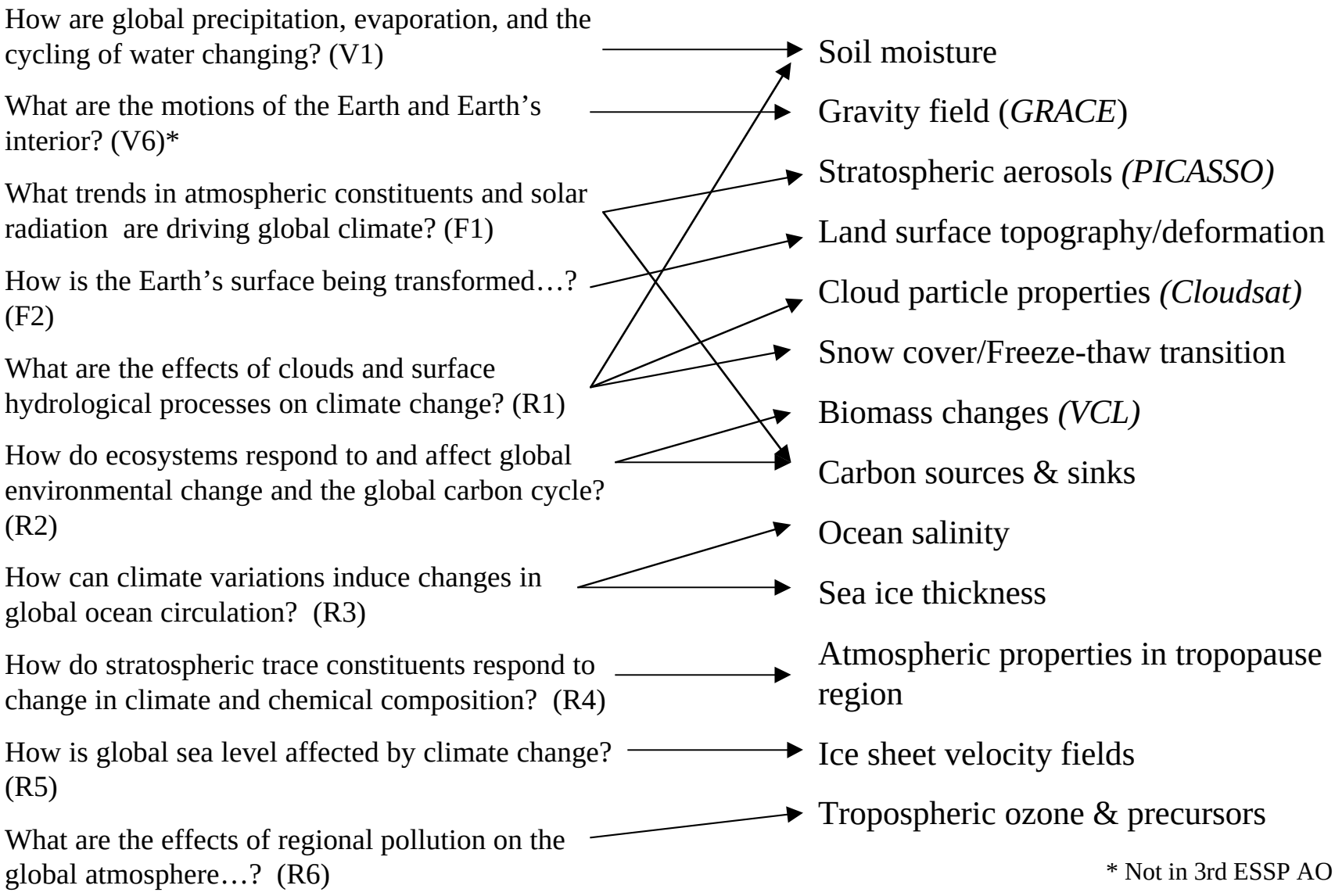
Earth System Responses and Feedback Processes

- What are the effects of clouds and surface hydrologic processes on climate change?
- How do ecosystems respond to and affect global environmental change and the carbon cycle?
- How can climate variations induce changes in the global ocean circulation?
- How do stratospheric trace constituents respond to change in climate and chemical composition?
- How is global sea level affected by climate change?
- What are the effects of regional pollution on the global atmosphere, and the effects of global chemical and climate changes on regional air quality?


Role of Exploratory Missions in the Research Strategy
Variability
Forcing
Response
Consequence
Prediction
Precipitation, evaporation & cycling of water changing?
Atmospheric constituents & solar radiation on climate?
Clouds & surface hydrological processes on climate?
Weather variation related to climate variation?
Weather forecasting improvement?
Global ocean circulation varying?
Changes in land cover & land use?
Ecosystem responses & affects on global carbon cycle?
Consequences in land cover & land use?
Transient climate variations?
Global ecosystems changing?
Surface transformation?
Changes in global ocean circulation?
Coastal region change?
Trends in long term climate?
Stratospheric ozone changing?
Stratospheric trace constituent responses?
Future atmospheric chemical impacts?
Ice cover mass changing?
Sea level affected by climate change?
Future concentrations of carbon dioxide and methane?
Motions of Earth & interior processes?
Pollution effects?
Requires both systematic & exploratory satellites
Requires systematic satellite observations
Requires exploratory satellite observations
Requires pre-operational and/or systematic/expl
Use available/new observations in better models
12/20/00

Earth Science Enterprise
National Aeronautics and Space Administration

ESE Research Strategy
Science V/F/R Questions & Measurements Requiring Exploratory Missions



* Not in 3rd ESSP AO

Summary

- Exploratory missions are essential to the success of the Research Strategy, and have high science value
  - Explore lesser understood Earth system processes, especially "Response" questions
  - Capture new ideas from the broader Earth science community
- Challenging to implement
  - Principal Investigator-led
  - New measurement techniques
- 3rd ESSP AO incorporates lessons learned from AO 1&2 to help overcome these challenges